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### GOELDI'S "OS MOSQUITOS NO PARÁ."

BY FREDERICK KNAB,

WASHINGTON, D. C.

This handsome quarto by Dr. Emilio Augusto Goeldi, published as Memoir IV of the Museu Goeldi (Pará Museum), deals with the mosquitoes of Pará (Brazil). The species treated of are chiefly those that molest man, their biology and relation to hygiene and a large part of the work is devoted to *Stegomyia fasciata* and *Culex fatigans*, preëminently the town mosquitoes of the tropics. The 154 pages are replete with interesting data and suggestive ideas. The author throughout, is careful to distinguish between fact and theory, so that the volume is a highly inspiring one to students of this subject. The text is in Portuguese, unfortunately made difficult for those not proficient in the language, by a rich and picturesque literary style, which aims to be popular as well as scientific, and must certainly make it attractive to Brazilian readers. There are fifteen plates, with numerous figures, illustrating the life histories of the various species, and five very fine color plates figuring the imagos of fourteen species, in most cases of both sexes.

In this work are brought together the observations published under the same title in two previous bulletins (1902, 1904), augmented by a great deal of new matter, and detailed accounts of the early stages of most of the species considered, and in the fourth chapter is appended the paper on *Stegomyia fasciata* read before the International Congress of Zoölogists at Bern in August, 1904, and now translated from the

German into Portuguese. The book is divided into the following chapters : I, The mosquitoes of Pará considered as a public calamity ; II, Review of results of experiments made in 1903, particularly with *Stegomyia fasciata* and *Culex fatigans*, from the sanitary point of view ; III, Biological details ; IV, *Stegomyia fasciata*, the transmitting mosquito of yellow fever and the actual state of knowledge relative to the cause of the disease. The author did not, however, bring all his data together under their respective headings, which is troublesome to the reader, but perhaps inevitable with such wealth of material.

The first chapter opens with an introduction to the Culicidæ, definition of some of the more important genera and data on the distribution of species culled from Theobald's Monograph. The author then turns to the species of Pará. Of the 42 species recorded from Brazil, 18 have been found at Pará, 17 of them by the author ; five of these are new. This seems a very small showing for so favorable a locality ; but this is perhaps due to the fact that the author has given most of his attention to the biologic and economic part of the subject. I will only mention in comparison that more than 50 species of mosquitoes are known from the Island of Trinidad, and indications are that it is by no means exhausted. The genera known from Pará are *Anopheles*, *Megarhinus*, *Psorophora*, *Janthinosoma*, *Stegomyia*, *Culex*, *Taniorhynchus*, *Sabethes*, *Hæmagogus*, *Wyeomyia*, *Limatus* and *Trichoprosopon*. A number of these genera are not treated in the present work, but the author promises an account of them in a future paper. Then follow short notes on some of the species. *Megarhinus separatus* is not rare in the vicinity of the city. It is strictly a forest mosquito and diurnal. Its bite is reputed to be painful, but the author has not yet been able to verify this from personal experience. *Janthinosoma*, of which the author has taken *J. musica*, is dismissed, as, in the author's experience, of no faunistic importance. This seems remarkable, as elsewhere in tropical America *Janthinosoma* is one of the most conspicuous forms. In connection with *Stegomyia fasciata* its excessive abundance in the city, its diurnal habits and severe bite are noted. In the reviewer's experience the bite of *Stegomyia* can hardly be called severe ; indeed the bite is often hardly noticeable, and this, together with its stealthy habits, the more easily make it the transmitter of the dread yellow fever. *Culex fatigans* is spoken of as a horrible nocturnal scourge in certain parts of the city. *Taniorhynchus* is crepuscular, invades the dining room, flies onto the table and into

the plates. It alights leisurely and without ceremony upon the face and hands, and then bites painfully. It is of such a voracious disposition that it can easily be crushed without its attempting to escape. Of the beautiful *Sabethes*, with metallic colors and plumed tibiae, three species occur. They are diurnal forest mosquitoes and are sometimes common enough to become troublesome. They bite ferociously and leave a relatively intense inflammation, evidently due to the large dose of poison injected.

Of especial interest is the figure on Plate V, showing the attitude of *Sabethes longipes* in flight. The position of the hind legs, raised over the back and bent well forward, is characteristic of the entire subfamily *Sabethinae* — at least it holds good for the species of a number of genera that the reviewer has had opportunity to observe in nature. Those who have seen living specimens of *Wyeomyia smithii*, the only known representative of the group in the United States, will recall this very striking attitude, which has been described by Dr. J. B. Smith on p. 343 of his Report on the Mosquitoes of New Jersey (1904).

Turning now more particularly to the economic aspect of his subject, the writer states that four species are the most important in Pará, not only as physical torturers and destroyers of peace, but as a menace to health. Three of these have taken a firm footing within the city in the last few years and relieve each other in their daily attacks inside the house, greatly injuring the credit and reputation of Pará as a habitable tropical city. The fourth species holds the outskirts and vicinity and constantly threatens human existence in the swampy regions of the interior. Branded by modern science as the vehicle and transmitter of malarial fevers it constitutes a serious obstacle to the progress of the country and is directly guilty of serious injury to public prosperity. The mosquito last alluded to is *Anopheles* represented by *A. albipes*. The fearful abundance of this species at Macapá and in the region bordering Guiana, and coincident with this an epidemic of malaria, was observed upon two museum expeditions. The author convinced himself of the correctness of the popular statement that this mosquito has a strong predilection for forests of siriúba (*Avicennia*), and so numerous are they there that, even in passing through such woods in the daytime, the face and hands soon become black with them.

The second of the four above-mentioned important species is *Stegomyia fasciata*. The description of the insect, with an account of its distribution and its rôle in yellow fever, is followed by observations

upon the species in Pará. It is excessively abundant in houses and hovers over persons' heads in troops of four to ten or more. It bites from sunrise until evening and a person is bitten at least 50 or 100 times a day. Seeking out any uncovered part it inflicts its painful bite which afterward swells. There is not a minute of rest from day-break to nightfall; it is impossible to defend oneself against them and soon face, neck, hands and legs are covered with burning swollen points. The author exclaims, "I do not know of another factor in this city so hurtful and actually pernicious to intellectual work, to scientific study and investigation in the quiet of the cabinet and laboratory as this execrable creature which is called *Stegomyia fasciata*!" *Culex fatigans* follows in importance and insupportability as a nocturnal complement to the diurnal *Stegomyia*. Surprising, but perhaps after all not far from the truth, is the author's statement that he considers the nocturnal habit exceptional and that the majority of mosquitoes are diurnal. According to Dr. Lutz, *Culex fatigans* is the common nocturnal mosquito throughout Brazil, found everywhere and biting only at night. At Pará the abundance of this mosquito is simply astonishing; in the suburb of Nazareth it assaults the houses in clouds during the first hours of the night and fairly throws itself against the person. The hum of myriads of these mosquitoes, flying and in courtship, in a dark room is enough to make one's hair stand on end. "I am apprehensive each time I hear this odious music, when I think of the sad consequences to health, of which, in my firm conviction, it is the fatal precursor and messenger!" The writer here alludes to *Culex fatigans* as the transmitter of filariasis. While it is mostly the black race and its crosses that is persecuted by this disease there is great danger to everybody at Pará where black and white sleep without mosquito-bars in the same rooms, infested with this mosquito.

The fourth of the above-denounced mosquitoes is *Taniorhynchus fasciolatus*. While the author agrees with Dr. Lutz that this is a genuine swamp mosquito he adds that at Pará it enters the houses at twilight. Its bite is painful and it has a voracious disposition, yet it is ingenuous and phlegmatic, if not to say entirely stupid. The specimens observed at Pará differ from the colored figure in Theobald's work by their darker color, a circumstance which has already been noted by that author.

The biology of mosquitoes is next treated in a popular way and the differences in the early stages of *Culex*, *Stegomyia* and *Anopheles*

pointed out. A count of the eggs in two egg-boats of *Culex fatigans* gave respectively 270 and 225 eggs.

There is an interesting observation on the difference in food habits of the two sexes. Outdoors the males feed on ripe fruits and flowers; in the house they go to sugar, coffee, tea, wine, soups and all sweet substances, and abstain from sucking blood. The females are blood-suckers and the difference in food habits is brought out in the following experiments. In the first experiment mosquitoes were observed swarming about the sugar bowl. It was quickly covered with a paper cone and the mosquitoes within chloroformed. There were 37 dead mosquitoes — 1 ♂, 1 ♀ *Stegomyia fasciata*, and 33 ♂, 2 ♀ *Culex fatigans*. This experiment was repeated a number of times with only a slight variation in the percentage of the sexes. This was in the dining room, the second contrasting experience in the bed-room. Far in the night the author noticed that outside of a certain part the mosquito-bar, close to his face, the mosquitoes were dancing up and down in a manifest endeavor to find a hole that would admit them. With a sudden slap of the hand a number of them were crushed against the wall. Examination showed that there were 23 dead *Culex fatigans* — all females. And thus, in the bed rooms, there always proved to be an enormous majority of females in quest of blood, to the exclusion of the males.

An explanation of the blood-sucking habit is offered, as follows: Few readers, particularly in the tropics, have not had an opportunity to observe how any scratch or wound on exposed parts of the body is persecuted by a multitude of small flies and related insects which come to sip the blood-serum, a slightly sweetish substance. One also knows how, during dry periods, the margins of the eyes, for example in the large mammals, are persecuted by the same impertinent Diptera, attracted by the "aqueous humor" with which the eye-ball is moistened. Now all these small Diptera, in common with ordinary-sized one (*Stomoxys*, etc.) and other large ones like the Tabanids, indicate the path gone over by the hæmaphiles. The Culicids, primitively only sucking sweet juices, became acquainted with animal blood through the blood-serum of wounds. The males contented themselves with this, the females reached the point of intentionally perforating the skin to gain possession of the desired liquid. Seconded in this mission by a stouter beak better fitted for piercing than in the male, and thus taking advantage of the liquid so easily obtained to

gain strength for the demands of egg-production, a disposition to this proceeding would become a habit and normal, and finally an indispensable postulate. The sucking of blood, acquired accidentally as a secondary habit, becomes an essential factor in the mosquito's life in relation to the ripening of the sexual products of the female. Today these insects must have blood for the propagation of their species.

The description of the mating of mosquitoes is of great interest, as very little has been made known on this subject. The species observed is *Culex fatigans*, although the author fails to specify this. On a subsequent page, in the second chapter, he treats of the mating habits of *Stegomyia fasciata* and compares them with those of the present species. The swarms of *Culex* that enter the houses at night-fall in dense clouds are principally males which seek the females already there. The infernal music of innumerable mosquitoes assails one's ears and at the same time they dash against one's face. Striking light one sees the multitude dancing and cutting frantic capers. There are two swarms, one composed entirely of males, the other only of females. The sexes are guided towards each other principally by the song and one soon perceives that there are two sounds, the higher produced by the males, the lower by the females. The actual sexual union is wholly devoid of ceremony. Some female detaches herself suddenly from her companions and approaches the cloud of dancing males. Immediately she is seized by a male and united they retire from the swarm. It is not rare that such pairs forget all prudence and in their frenzy hit against everything and even roll upon the ground. In some cases a female is seized by two males at the same time and all three fall, rolling over each other in the fiercest sexual frenzy. Theobald says, "I have never seen a male *C. pipiens* or of any other European species indoors." In Pará the males of both *Culex fatigans* and *Stegomyia fasciata* daily invade the houses in swarms. Oviposition (of *Culex fatigans*?) is said to occur only at night. The observations on the localities where the eggs of *Culex fatigans* and *Stegomyia fasciata* are laid agree with those of Durham and Myers. *Culex fatigans* contents itself with any ditch, no matter how muddy or foul, puddles of waste water and drains, and is easily reared in the laboratory. *Stegomyia fasciata* is quite particular in the selection of breeding places. It prefers relatively clean water and is customarily found in the depressions of the horizontal rain-gutters on houses, in barrels, jars and other receptacles, in the still folded leaves of banana plants, the leaves of bromelias, etc. In captivity the

larvæ do not prosper in water containing other matter than their essential food, algæ and other cryptogams.

The paragraph on mosquitoes as agents of disease reviews what is now known on this important subject and briefly states the part taken by the different investigators in bringing out the facts. The species of mosquito that are known to transmit disease are enumerated and the diseases they carry. In the mention of *Filaria immitis* in the dog, transmitted by *Culex fatigans*, the writer states that he has found this disease in dogs at Rio de Janeiro and sometimes the left auricle of the heart is filled with a ball of these worms.

Under the caption "Practical results which urgently claim attention" the various methods of mosquito control are discussed. The baneful effect of mosquitoes is again emphasized, not only as direct agents of yellow fever and other diseases but also as the destroyers of spiritual peace and the producers of neurasthenia through the constant infliction of physical pain.

Chapter II gives a series of experiments with *Stegomyia fasciata* and *Culex fatigans* to ascertain the relation of meals of blood to copulation and to oviposition. Upward of 220 adults of both sexes of *Stegomyia fasciata* and 260 of *Culex fatigans* were used in these experiments. At first captured mosquitoes were used, but later the experiments were carried on with bred specimens. The fertilized females were fed with honey and water on the one hand, and with human blood or that of the guinea pig on the other. It is shown that one or more meals of blood are essential to the development of the eggs. Lack of space forbids giving even a synopsis of these experiments. It is only possible to give the author's final conclusions, which apply more particularly to *Stegomyia fasciata*, and state that in general they are borne out by the experiments. In brief his conclusions are as follows:

1. Honey prolongs the life of the mosquito in captivity, and is taken with avidity, not only by the female, but above all by the male.
2. Blood of vertebrates is eagerly and persistently sought by the female; obtained by sucking it shortens life as further explained. Blood drawn in other ways, although fresh, is refused or accepted with indifference not only by the males but also by the females.
3. Sucked blood is a food which favors and accelerates the laying of eggs and produces a certain, energetic and immediate reaction in the organization of the female, perceptible from the first ration.



4. Honey, on the contrary, has a retarding, interrupting, or at least neutral effect upon oviposition. The same is true of other sweet liquids and vegetable food.

5. With certain mosquitoes, in captivity, we have the power to prolong life and suppress oviposition, or bring about prompt oviposition by withholding or supplying blood as food.

6. It is a fact that in previously fertilized females of *Stegomyia fasciata* the faculty of laying fertile eggs can be preserved latent during periods of from 23 to 102 days and called to life at pleasure by changing the diet to one of blood.

7. In other words: A diet of honey is of advantage to the individual by prolonging life, but of disadvantage to the species, for it retards reproduction. A blood diet, on the contrary, is prejudicial to the individual, for it shortens life, and most advantageous to the species, as it favors reproduction.

8. We have the right to call blood an indispensable factor in the production of fertile eggs. By the above experiments, what has so far been only a hypothetical supposition, has now been definitely proven.

9. Unfertilized females, bred in captivity and in strict isolation, readily accept blood. Copulation is not a necessary preliminary to enable the female to practice hæmatophagy.

10. These unfertilized females of *Stegomyia* may lay eggs, though these are not fertile and do not produce larvæ.

11. Oviposition completed, the female, both of *Stegomyia* and of *Culex fatigans*, dies in the following days, in most cases immediately afterward. The female survives in cases where oviposition is incomplete until the fractional deposits have made up the total.

12. In order to make a complete deposit of eggs it is necessary that the female of *Stegomyia* should have several successive rations of blood, at least two or three. With *Culex fatigans* the results on this point have not been equally decisive.

13. The respective interval between the meal of blood and oviposition, taking the average, for *Stegomyia fasciata* is 3.7 days = 88.8 hours, and for *Culex fatigans* 3.5 days = 84 hours.

14. The interval from the time the eggs are laid to the appearance of the larvæ, taking the mean, is, for *Stegomyia fasciata*, 4.5 days = 108 hours, and for *Culex fatigans* 1.8 days = 43.2 hours.

The second chapter closes with an extensive account and discussion of the habits of *Stegomyia fasciata*, which clearly demonstrates that this

species has become completely domesticated. While certain species of mosquitoes probably persecute by preference particular animals, among all the mosquitoes there is none that has so exclusively adapted itself to the persecution of man in the tropics as *Stegomyia fasciata*. Along the Atlantic littoral of South America it fastens upon the heels of man wherever he settles in numbers and the houses are concentrated into cities of any size. Steam navigation has been the means of spreading the species, and only by taking into account this fact can its present geographical distribution be understood in its details. A valuable illustration is furnished by the manner in which *Stegomyia* is little by little conquering the Amazon valley. It has departed, by exception, from the littoral route, and entering in a perpendicular direction to the coast line, has reached the remote interior. It has established itself at Manáos, capital of the state of Amazonas, a rapidly growing city of modern aspect 1,600 kilometers from Pará. However, according to reliable information obtained by the author, the species has not made itself felt in Santarém, Faro, Monte Alegre and Obidos, all cities at a much lesser distance from Pará. The author thinks that while there may be other secondary factors, the principal reason for this negative condition is the small size of these towns. The author believes that an inquiry into the data when yellow fever first appeared at Manáos, and the beginning of steam navigation with Manáos as a terminus, would show an intimate and significant relation between these two facts. The great waterway, with its direction nearly parallel to the equator, navigable for large ocean vessels to its upper reaches and with its climatic conditions most favorable to this eminently tropical mosquito, will prove an excellent highway in the conquering march of *Stegomyia*. Even while the sheets were in press, the newspapers of Pará brought telegraphic notice that the "black vomit" had made its appearance in Iquitos (Peru) on the upper Amazon. In Pará, in certain parts of the city, *Stegomyia* abounds to the point of making existence unbearable, particularly for those whose professional duties keep them at the work-table. The hot hours of the day are those in which it shows itself most blood thirsty and insistent. When one perspires slightly it persecutes by its bite with a tenacity and cruelty of which it would be hard to find another example. That the growing insolence of its persecutions goes parallel with the increasing perspiration of our body is something which must impress every attentive observer. It is evident that the perspiration of

our body plays a significant rôle in the life of this mosquito. During the hot hours of the day the head and hands of persons resting clothed, in hammock or bed, are besieged by a cloud of perhaps ten or fifteen *Stegomyias*, mostly males, in incessant serpentine evolutions. Even the males are aggressive during these hours and persecute any uncovered part of the body to suck sweat. If they do not succeed in biting it is not from lack of desire, but owing to the weak mouth-parts. Although it has been frequently asserted that the male *Stegomyia* bites and sucks blood, neither the author nor any of his colleagues have ever detected one in the act or found one dilated with blood. However, they do alight upon the person, and the author thinks they produce an irritation that only differs in degree from that of the female's bite. While the male does not succeed in perforating the epidermis it certainly irritates it, and a close study of the male mouth-parts would probably show an unusual development for that sex. The disagreeable sensation produced by the males is augmented by their truculent hum, uttered in a thin concert voice.

The habits of *Stegomyia* are now discussed in their bearing on the theory of the origin of the blood-sucking habit propounded on a previous page. Clearly sweat belongs to the same order of products as the others sought by Diptera, the blood serum and the moisture on the edge of the eyes. When *Stegomyia* first associated itself with man both sexes fed upon his perspiration. From this stage the females progressed to the habitual perforation of the epidermis and became professional suckers of human blood. The males continue in the historically more ancient stage of lappers of sweat and similar secretions of the human body.

When *Stegomyia* is abundant one observes that the males show a certain aloofness and tendency to congregate apart from the females in little clouds of 15 to 20 or more. This manifests itself, for example, when the males congregate over the edge of a table or cabinet while the females are circulating about the room, or they collect about the upper part of a mosquito-bar while the females are reconnoitring beneath the bed. These elevated positions are points of vantage from which the males pounce upon any female that they detect crossing the area of their dominion.

*Stegomyia* is a singularly light-loving mosquito. This is shown by the merry hum of the males as well as the females, dancing in animated swarms, when the moderate sunlight of late afternoon shines

into their cages. The sounds produced under these conditions were determined with the assistance of two musically educated colleagues and by the use of a cither and diapason with determined vibrations. The note of the female corresponded to C in the treble clef and that of the male to the A above. The male note has 880 vibrations, that of the female 480, and the two sounds hold the relation of a sextad to each other. In both cases the impression was obtained that along with the principal note the respective octaves were heard, so that the timbre was obscured by the concomitant notes. A certain effect upon the height of pitch is exercised by the greater or less dilation of the abdomen with food and perhaps also in certain psychic states and under the influence of mutual suggestion. According to Nuttall and Shipley the note of *Anopheles maculipennis* in the male coincides with that of *Stegomyia* while in the fed female it is in the neighborhood of low C with 240 vibrations, an octave lower than in *Stegomyia*.

Little appears to have been made known about the copulation of *Stegomyia*. The author states that he has seen it millions of times and sees it every day, but, as yet, has not been able to describe it satisfactorily in its minor details. In general outline the process is as follows: a male, from his outlook, precipitates himself upon a female that comes flying near and attaching himself to the under side allows himself to be carried in gentle flight for a few seconds (not more than two or three) and again departs. It is the work of a moment and it is really surprising with what rapidity the act is accomplished. The flight is so short that it is executed without difficulty within a cage, a fact which makes it possible to breed successive generations of the species in captivity. As well as one can judge, without previously marked individuals, the same male copulates several times in rapid succession with diverse females that approach. The process differs from the bacchanals of *Culex fatigans*, described on a previous page, in that there are not two distinct swarms, one of males, the other of females. Still there is a tendency to keep separate, a kind of antagonism already alluded to. The nuptial flight of *Culex fatigans* is likewise only of a moment but it seems to require more space and therefore is not realized in captivity with the facility, one might almost say mathematical precision, of *Stegomyia*.

The writer thinks that *Culex fatigans* is more obstinate, timid and rebellious in behavior and more refractory to domestication. He believes that a proof of this is the singular circumstance that of all

the trials made with females in captivity, both captured and bred ones, only one sucked blood. *Culex fatigans* shows itself much inferior to *Stegomyia* in intelligence and this agrees well with the idea that, like other hæmatophagous insects, this mosquito is principally found in relation with a definite vertebrate host. The author believes that primitively *Culex fatigans* was less partial to the human species than to certain domestic animals and his suspicion points mostly to its being an inquiline of poultry-houses. Is it not possible that in this evident intellectual diversity of these two species of mosquito the diversity of their respective primitive hosts is reflected? Surely no one will dispute that it requires a more expert mosquito to persecute man than poultry, cats or dogs.

Discussing the original home of *Stegomyia fasciata*, the author expresses his belief that it is of African origin. He bases this idea largely upon a study of the geographical distribution of the genus *Stegomyia* by means of the data gathered from Theobald's Monograph. Of the 21 known species of the genus, eleven, or more than half, are African, while only four are American. The author fails, however, to take into account the fact that our knowledge of the mosquito fauna of tropical America is extremely fragmentary. At least three additional species of *Stegomyia* are now known from the West Indian region, which, with the neighboring coasts, most likely represents the home of the American *Stegomyias*.\* *Stegomyia fasciata* is now so widely dispersed that a study of the species itself will hardly furnish a clue to its original habitat. The author believes that *Stegomyia fasciata*, along with other afflictions such as filariasis and the sand flea (*Sarcopsylla penetrans* L.), has followed in the wake of the slave trade probably in quite early times. Of course it is quite as likely that the reverse is true and that the species has been disseminated from America. The whole question is inseparably bound up with that of the origin of yellow fever and perhaps the history of this disease will furnish proper data to settle the question. The author touches upon this part of the subject in Chapter III, where he resumes the discussion of the probable

\* Since the above was written these three species referred to have been described by Mr. D. W. Coquillett. Two of them, together with *Stegomyia sexlineata* Theob., are placed by Mr. Coquillett in a new genus *Gymnometopa* (Proc. Ent. Soc. Wash., VII, 183). It should be noted that it is highly doubtful that the genus *Stegomyia* represents a distinct and homogeneous group. Most of the recently made Culicid genera are based upon very unsatisfactory characters and do not represent natural groups, as is clearly apparent from a study of the larvæ.

origin of *Stegomyia fasciata*. He concedes that the malady which carried off part of the crew of Columbus was most likely the yellow fever, but protests that this does not constitute a proof against its previous existence in Africa. A further argument is sought in the close association of *Stegomyia fasciata* with man and its partiality to large cities. He asks where were the large cities on the Atlantic coast between the Antilles and the Rio Plata? He further states that the indigenous American was at all times what he still is to-day; jealous of his absolute freedom, he has neither the habits nor the inclination necessary to concentrate himself in cities of really large size. The characterization of the native American which follows is a very faithful portrait of the Amazonian Indian and will apply, in the essential points, to our North American Indians as well. He contrasts with the retiring characteristics of our Indians the excessive sociability of the African. All the accounts of African travelers abound with exclamations of surprise at the number of towns reaching a size beyond easy estimation. The author has, however, entirely ignored Mexico and Central America, peopled in great part by natives of advanced culture and entirely different character from the primitive races to the north and south. Surely the writer is not wholly ignorant of the historical accounts of the dense population of peaceful agriculturalists that inhabited the region at the time of its discovery and the extensive cities, doubtless of great age, that existed then. We know that even upon the author's own ground, the lower Amazons, at the time of the discovery there was a dense agricultural population congregated in large towns — a population probably far in excess of that of the present day.

The author likewise assumes an Ethiopian origin for *Culex fatigans* and points out the close correspondence in the distribution of this species and *Stegomyia fasciata*, as shown in the maps given by Theobald, and this he believes to be by no means accidental. It is fitting here to call attention to the uncertain status of some of the species of *Culex*, particularly those of the group to which *C. fatigans* belongs, and the absolute impossibility, in some cases, to refer specimens to their proper species with certainty. The author himself, on another page, points out that the variety *skusii* of *Culex fatigans* must be a distinct species, as the larval characters differ widely in the two forms. From a study of the larval material brought together by Dr. L. O. Howard for his forthcoming monograph of the Culicidæ the reviewer has

reached the conclusion that the American form known as *Culex fatigans* represents a distinct species peculiar to the tropical and subtropical regions of this hemisphere.

The author believes that *Stegomyia fasciata* and *Culex fatigans* are inseparable allies, always to be found together, the nocturnal *Culex fatigans* supplementing the diurnal *Stegomyia fasciata* in the persecution of man and the two constituting a strong combination against him. He believes that future studies will show that the influence of these two mosquitoes, over and above the grave diseases which they transmit, is the principal cause of tropical anemia.

Attention is called to the occurrence of dwarf specimens, both of *Stegomyia fasciata* and of *Culex fatigans*, a circumstance of considerable importance as they succeed in passing through screens effectual against normal mosquitoes. At certain seasons these dwarfs are more numerous and even become the predominating form. Thus it appeared that in the last weeks of October and in November, just before the opening of the rainy season, these small females were particularly numerous. These dwarf mosquitoes are the product of adverse conditions during development, such as the reduction of water and food in the dry season, so that there may be said to be a small æstival generation. It is a wrong opinion that the individuals of this dwarf race are less aggressive and blood-thirsty than those of normal size; they behave in every way the same and their bite is equally painful.

One cannot suppose that on the whole Brazilian coast, southward to Rio Janeiro or Santos, there is a single place where the development of *Stegomyia* ever comes to a standstill. There are larvæ throughout the year, although there will be fluctuations in the rate of development corresponding to hot or cold, wet or dry season in the different localities. Inquiries into these conditions gain particular importance through their relation to the periodicity of yellow fever.

From the experiments it appears that *Stegomyia fasciata* shows a decided preference for human blood over that of the guinea pig, and human blood seems to have a more favorable effect upon oviposition. Reptilian blood, that of a lizard (*Tropidurus torquatus*) was offered but not accepted.

As all other mosquitoes are extremely sensitive to currents of air it is remarkable that *Stegomyia* is quite indifferent to even a strong wind. The author found that a strong wind blowing into a window, or the current of air from an electric fan, did not in the least interfere with

the evolutions and biting of the *Stegomyias*. It appears likewise to be quite indifferent to strong odors as in one case that from a floor saturated with creoline did not affect them. Strong mediums are necessary, such as fumes of sulphur, chlorine or strong fumigation with pyrethrum.

The question whether *Stegomyia fasciata* bites at night is of importance in view of the often mentioned "diarios de Petropolis," that is, the security from yellow fever enjoyed by those who spend the day in the city of Rio de Janeiro but return to their homes in the nearby mountains before nightfall. The author professes that he approached this question with great scepticism. However now he is in possession of quite a number of perfectly verified cases in each of which the mosquito was taken "en flagrante" and identified by him. These cases occurred both at Rio de Janeiro and at Pará. Nearly all the cases observed at Pará occurred in nearly the same manner, between the hours of eight and eleven at night while the author was writing by an electric light, the window open. The mosquitoes that alighted upon the hands and sucked blood were generally *Tæniorhynchus fasciolatus* or *Panoplitès titillans* but now and then a female *Stegomyia* presented itself. The bites personally observed at Rio de Janeiro occurred during the same hours in a room of the library. The author always noticed that during the day he was more persecuted by *Stegomyia* in that room than elsewhere and he quickly discovered that the mouldings and the upper and under sides of the shelves were the chosen hiding places of these mosquitoes. These cases, however, are not the rule but exceptional; perhaps one in a hundred bites at night and then only with light, not in complete darkness. The weak light of the night-lamp in a sleeping room is perhaps sufficient. These observations do not weaken the statement that *Stegomyia fasciata* is essentially a diurnal mosquito. Now and then some female overpowered by hunger prolongs its hunt into the night, above all when stimulated and guided by the light in a room. That *Stegomyia* will readily accept blood at night in captivity the writer considers an anomaly due to the unnatural laboratory conditions. There is a popular saying that to get rid of mosquitoes it is only necessary to put out the light. This advice, if it does not simply allude to the fact that the healthy organism, tired from the day's occupation, falls asleep more readily in a dark room, must refer to *Stegomyia fasciata*. In the case of *Culex fatigans* and *Anopheles* the promised result will certainly not be realized.

But there is still the possibility that perhaps the female *Stegomyias*



seeking blood at night are themselves the victims of an anomaly and acting under a morbid impulse, perhaps produced by a parasite. Perhaps there is here some relation with the agent of yellow fever!

The third chapter, "biological details," contains a great deal of interest, and it is to be regretted that the details, particularly of larval structure, are not more full. The plates that accompany this chapter are of great interest, particularly the figures from photographs of eggs, larvæ and pupæ, more or less magnified. The figures from drawings, we are sorry to say, are not equally commendable, and, at least in some cases, appear superficial and inaccurate. Some of these inaccuracies will be pointed out in connection with the following notes. Sixteen species of Culicidæ, three Chironomiæ and a *Simulium* are dealt with, but of some of the species the early stages remain unknown and only notes upon the imago are given.

*Culex fatigans* and *Stegomyia fasciata* are treated most fully, and each of these species is illustrated by two double-page plates. One of these plates is entirely given up to the eggs of *Culex fatigans*, and the figures, from photographs, of the eggs singly and in rafts, are very excellent. As the author remarks, these eggs do not appear to differ in any way from those of *Culex pipiens*. Regarding the small globule at the pointed end of the egg, the writer at first followed the supposition of previous writers that it is air. Closer study of its optical qualities and behavior in various liquids used in microscopic technique showed that it is of a gelatinous or mucilaginous substance. The globule is detached by the slightest pressure and in the water swells and then disappears altogether. At the same time the author became convinced that the entire base of the fresh egg-raft is covered by a layer of gelatine, similar to the substance present in so many other insect eggs, and even those of vertebrates. He attributes a hydrostatic function to the globule. Both the globule and the lower layer disappear before the breaking up of the egg-boat, which begins soon after the larvæ have hatched. The author thinks that this gelatinous substance may perhaps furnish the first food to the young larvæ. The cup-shaped appendix on the rounded end of the egg has been figured by several authors, but without comment. The author thinks it is connected with the intra-ovarial period, the remnant of the germinative chamber and entirely without physiological significance after the egg is laid. The figure of the sculpture pattern of the interior of the cup shows series of points arranged around a central round depression.

The female of *Culex fatigans*, in ovipositing, shows great predilection for water containing animal matter. A vessel in which the skulls of several small mammals were being macerated after two or three days contained a great number of egg-boats — at least 100 or 200 — and further tests gave the same result. This fact could be utilized and the mosquitoes induced to lay their eggs in trap-jars, where the eggs could then be destroyed. Unfortunately the details of the larval characters given in the text and figures are insufficient and will not serve to separate this species from *Culex pipiens*. The author himself calls attention to the close resemblance between the two larvæ, but wisely remarks that it would be premature to pronounce upon the relative value of these two forms. He urges that describers should be exact and adopt a standard for description, else a labyrinth of error and confusion must result.

*Culex confirmatus* is noticed in Pará mostly in the dry season and frequents dry fields and gardens when water is present in ditches or natural depressions. It was noticeably abundant in a garden near Rio de Janeiro, and showed itself impertinent and besieged one in clouds of ten or twelve. It is diurnal and loves the light, and people are mostly troubled by it during the hottest hours with burning sun. The author questions that Grabham could have had the same species under observation when he states that "this species appears to be active only during the night." As a matter of fact, neither the larva characterized by Grabham (Can. Ent., v. 37, p. 404-405) nor by Dyar (Journ. N. Y. Ent. Soc., v. 13, p. 23-25) in the least resemble that figured by the present writer. The larva figured cannot be of this species, but is a *Culex* in the restricted sense, and the author correctly points out its relationship to our *Culex territans*. The large and stout antennæ bear a tuft at the set-off three-fourths from the base, and the breathing tube is extremely long and slender. The author twice succeeded in obtaining eggs from captive females fed with guinea-pig blood. The eggs are lanceolate-oval and are laid singly.

In the larva of the *Culex sp. indet.* from the forest of Murutucú close to Pará, attention is called to the pointed form of the anal gills, resembling those of the *Psorophora*. The figure of the labial plate is very characteristic, the pecten teeth of breathing tube bear a fringe of spines and the scales of the comb are large and simple. Doubt is, however, thrown on these characters by the two figures of antennæ, of entirely different types, for this same species and leads one to infer that the author has confused two species.

Of especial interest are the author's observations on the early stages of two species of the genus *Teniorhynchus*, *T. fasciolatus* and *T. arribalzaga*. The first information relating to the early stages of this genus was given by Dr. Goeldi in a footnote on p. 27 of his first bulletin on the mosquitoes of Pará, published in 1902, and notes furnished by him were incorporated in Theobald's Monograph, v. 3, 1903, p. 257 and 269. These observations are based upon *T. fasciolatus* but answer as well for the other species, as no essential differences were noted between the two. It is decidedly a forest mosquito, and only enters houses occasionally in the evening. It shows itself sensitive to confinement and does not survive it long. Of 170 captured females fed with blood only 25 laid eggs. The eggs are laid in a double-rowed chain, fastened together like those of *Culex pipiens*. The chain is rather strongly convex upon the lower side, and rests upon the water after the manner of the egg-raft of *Culex pipiens*. It is only after the larvæ have been hatched that it falls upon its side and disintegrates. The number of eggs in a chain was from 60 to 63 and the female dies very soon after the act of oviposition. The eggs hatch in about four and one half days. The author compares the shape of the eggs to that of a champagne bottle but the accompanying figures do not show the pronounced neck that this description implies. The surface of the egg is covered with coarse conical papillæ. The young larvæ are of very remarkable appearance well shown in two photographic figures. The antennæ are very large and of peculiar shape but are not two-jointed as the author indicates in the drawing of fig. 76. The mouth tufts are large, the tracheal tubes very slender. Most remarkable is the form of the breathing tube, the basal portion very broad and rounded off, narrowed beyond the middle to a very slender tube terminated by a whorl of spines. The slender terminal portion somewhat exceeds in length the broad basal part and the general aspect reminds one of a peaked helmet. All attempts to rear these larvæ failed and they died after a few days. These larvæ agree quite closely in general appearance with the young larvæ of *Teniorhynchus perturbans*, described and figured by Dyar and Currie in Proc. Ent. Soc. of Washington, v. 6, 1904, p. 218-220. In this last-mentioned species, however, the eggs, about 150, are laid in a raft. No clue has yet been given to the natural habitat or food of these strange larvæ and it is to be hoped that Dr. Goeldi, in such favorable surroundings, will succeed in solving the mystery of these strange larvæ.

The eggs obtained by the author from another species, *Tæniorhynchus fulvus*, leads him to express doubt that it should be retained in the same genus. He calls attention to the great dissimilarity of the imago to those of the two first-mentioned species and proposes the generic name *Chrysoconops* for this species. The eggs are short, very broad at the middle, tapering to a blunt point at each end, almost rhombic in shape. They are laid detached, in a double row which soon becomes disarranged.\*

Very good figures are given of *Mansonia titillans* in the act of oviposition and of its eggs. The eggs are laid detached, in a double mass. They are broadest at middle, tapering at both ends, but much more slender than those of *Tæniorhynchus fulvus*.

A plate is devoted to the eggs of *Janthinosoma musica* and *J. lutzii* which are likewise laid singly. The surface sculpture consists of recumbent spines.

*Trichoprosopon nivipes* demands especial attention as it is the representative of Theobald's subfamily Trichoprosopina of which the larvæ were heretofore unknown. The author obtained larvæ from the water between the leaves of Bromeliads, at the base of banana leaves and like situations. The appearance of the pale larvæ is well shown in a photographic picture and their general resemblance to the Sabethinæ quite apparent. The figure of the mandibles hardly conveys the correct impression as only the slender strongly dentate portion is shown. The mandibles remind one strongly of the Chironomidæ, particularly when seen endwise and the great thickness of the base is apparent. There is reason to believe that in his notes on the young larva of *Trichoprosopon*, accompanied by a figure of the breathing tube, the author had before him the larva of *Limatus durhami* which is often found associated with *Trichoprosopon*. The pupa of *Trichoprosopon* has very small terminal paddles and the last and penultimate segments bear ample tufts of 24-26 and 14-16 hairs respectively, while the other segments bear only single hairs.

*Limatus durhami*, in the imago as in the larva agrees with *Trichoprosopon* in habits. Imagos in confinement refused to suck blood and laid no eggs. When fed honey they only lived from 2-8 days. The larva is characterized by a very elongated abdomen and a small, almost rectangular head. The antennæ are very small. The breathing tube

\* Mr. D. W. Coquillett has recognized in *Tæniorhynchus fulvus* a species of *Psorophora*, so that *Chrysoconops* Goeldi becomes a synonym of *Psorophora*.

is short and bears, both above and below, a series of hairs in pairs and singly. The comb consists of half a dozen scales in a row. The pupa is more elongate than that of *Trichoprosopon* and has, like it, tufts upon the last two segments. The paddles are very poorly developed.

The showy *Megarhinus separatus* is a common species in the Amazon region. Mr. A. Ducke, entomological preparator of the museum, has experienced its bite and compares it in painfulness to the sting of a wasp. He also obtained the eggs, larvæ and pupæ. The eggs are elongate, almost cylindrical, and float upon the water in groups of four to six lying side by side. One end of the egg is smooth, while more than half of it is granular and covered with very prominent tubercles. These tubercles are more or less constricted at the base and appear to have an opening at the tip. They serve to keep the egg afloat by the air retained between them. When the larvæ are hatched the egg splits open lengthwise at the smooth end, a mode very distinct from that observed in other mosquito eggs. The larva greatly resembles that of our North American *Megarhinus portoricensis*. Distinguishing characters are furnished in the labial plate, mandibles and antennæ. The predaceous character of the larvæ appears to have escaped the author.

*Anopheles albipes* is a rather rare mosquito at Pará and only appears occasionally in the outskirts at dark. The author did not succeed in finding the larvæ in their natural habitat. Eggs were obtained in the usual manner from a female fed successive rations of blood. Figures are given of the eggs greatly enlarged and also one to show their stellate grouping as laid upon the water. The young larva has two very long terminal hairs. This mosquito is distinguished by the common people from the ordinary mosquito or "*carapaná*" by the popular name "*moroçoca*."

The chapter closes with descriptions of two new species of *Chironomus*, — *C. calligraphus* and *C. holoprasinus*, — of a little biting fly "*miruim*," a species of *Ceratopogon*, under the name *Hæmatomyidium paraense*, and of the famous "*piú*" of the upper Amazons as *Simulium amazonicum*. The eggs and larva of *Chironomus calligraphus* are figured, as also the imago of the *Ceratopogon* and its wing greatly enlarged.